What is claimed is:

1. A method for forming a trench capacitor, comprising:
providing a semiconductor substrate, wherein a deep trench and a deep trench capacitor are formed therein, the deep trench capacitor having a node dielectric layer and a storage node, the node dielectric layer covering a sidewall and a bottom portion between the deep trench and the deep trench capacitor, and the storage node filling the deep trench to a predetermined depth;
ion implanting the top portion of the deep trench to a predetermined angle to form an ion doped area on a single sidewall of the semiconductor substrate and the top surface of the deep trench capacitor;
oxidizing the semiconductor substrate to form an oxide layer on the ion doped area;
forming a sidewall layer on the exposed semiconductor substrate using the oxide layer as a mask;
removing the oxide layer;
forming a barrier layer on the sidewall of the deep trench; and
filling a conducting layer in the deep trench.

2. The method for forming a trench capacitor of claim 1, wherein the ion source of the ion implantation is a gas mixture containing F, which promotes growth of the oxide layer.

3. The method for forming a trench capacitor of claim 2, wherein the gas mixture containing F is fluorine gas.

4. The method for forming a trench capacitor of claim 1, wherein the sidewall layer is an epi-silicon layer.

5. The method for forming a trench capacitor of claim 1, wherein the material of the sidewall layer is the same as the semiconductor substrate.

6. The method for forming a trench capacitor of claim 1, wherein the barrier layer is an oxide layer or a nitride layer.

7. The method for forming a trench capacitor of claim 1, wherein the conducting layer is a poly layer.

8. The method for forming a trench capacitor of claim 1, wherein the node dielectric layer is a silicon nitride layer.

9. The method for forming a trench capacitor of claim 1, wherein the storage node is an n+ type doped poly.

10. A method for forming a trench capacitor, comprising:

providing a semiconductor substrate, wherein a deep trench and a deep trench capacitor are formed therein, the deep trench capacitor having a node dielectric layer and a storage node, the node dielectric layer covering a sidewall and a bottom portion between the deep trench and the deep trench capacitor, the storage node filling the deep trench to a predetermined depth, and the deep trench has a first sidewall and a second sidewall;

ion implanting the deep trench top portion to a predetermined angle to form an ion doped area on

the semiconductor substrate of the first sidewall and the top surface of the deep trench capacitor;

oxidizing the semiconductor substrate to form a first oxide layer on the ion doped area and a second oxide layer on the second sidewall, wherein the thickness of the first oxide layer exceeds the second oxide layer;

removing the second oxide layer to expose the semiconductor substrate of the second sidewall of the deep trench;

forming a sidewall layer on the second sidewall using the first oxide layer as a mask;

removing the first oxide layer to expose the semiconductor substrate of the first sidewall;

conformally forming a first barrier layer on the first sidewall, the sidewall layer, and the deep capacitor;

forming spacers on the first sidewall and a sidewall of the sidewall layer sequentially;

filling a first conducting layer in the deep trench;

etching back the first conducting layer and the spacer to a predetermined depth; and

conformally forming a second barrier layer on the first sidewall, the sidewall layer, and the first conducting layer, and the deep trench being filled with a second conducting layer.

11. The method for forming a trench capacitor of claim 10, wherein the ion source of the ion implantation is a gas mixture containing F, which promotes growth of the oxide layer.

12. The method for forming a trench capacitor of claim 11, wherein the gas mixture containing F is fluorine gas.

13. The method for forming a trench capacitor of claim 10, wherein the sidewall layer is an epi-silicon layer.

14. The method for forming a trench capacitor of claim 10, wherein the material of the sidewall layer is the same as the semiconductor substrate.

15. The method for forming a trench capacitor of claim 10, wherein the first barrier layer is a nitride layer.

16. The method for forming a trench capacitor of claim 10, wherein the spacer is an oxide layer or a nitride layer.

17. The method for forming a trench capacitor of claim 10, wherein the first conducting layer is a poly layer.

18. The method for forming a trench capacitor of claim 10, wherein the second barrier layer is a nitride layer.

19. The method for forming a trench capacitor of claim 10, wherein the second conducting layer is a poly layer.

20. The method for forming a trench capacitor of claim 10, wherein the node dielectric layer is a nitride silicon layer.

21. The method for forming a trench capacitor of claim 1, wherein the storage node is n+ type doped poly.